International Journal of Food Science and Nutrition
ISSN: 2455-4898; Impact Factor: RJIF 5.14
Received: 07-06-2019; Accepted: 09-07-2019
www.foodsciencejournal.com
Volume 4; Issue 5; September 2019; Page No. 43-49

Process optimization of low cost weaning food by incorporating multigrains mixes

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Abstract
Malnutrition is one of the major public health problems among children in developing countries. It affects the child at the most crucial period i.e. stage of development, which can lead to permanent impairment in later life. A number of cereals and legumes that are readily available and found to have nutrient potentials which could be enhance by germination and complement one another if properly processed and blended especially by the rural and poor mothers during weaning period. The objective of this study was to formulate composite weaning foods using cereals, legumes and analyze them for sensory attributes as well as nutrients and cost of the prepared products. Wheat Grits (WG), Maize Grits (MG), Bengal Gram Flour (BGF) was used in different levels. Four blends (treatments) were formulated and were subjected to organoleptic analysis for testing various sensory attributes via nine point hedonic scale. ANOVA was used for the statistical analysis. The nutritional composition and cost of the different formulations was evaluated. There were significant ($P< 0.05$) differences between overall acceptability of all the blends. T3 (WG: MG: BGF, 40:25:35) was liked very much while T0 (WG, 100), T2 (WG: MG: BGF, 50:20:30), T1 (WG: MG: BGF, 60:15:25) were moderately liked by the panel of judges. Protein, fat, moisture, ash, carbohydrate, calcium and iron were higher T3 except fibre and iron. The cost of instant baby food (Rs/ 100g) ranged from Rs 4.55-4.31 The study is part of the effort to provide home-based complementary foods that can be more cost effective to the low income families. The product could be served in the form of porridge with water/milk.

Keywords: malnutrition, weaning, multigrain, proximate analysis

Introduction
India is home to 40 percent of the world's malnourished children and 35 percent of the developing world's low-birth-weight infants. Every year near about 2.5 million children lose their lives in India, accounting for one in five deaths in the world. The problem of malnutrition in children continues to be critical in most of the under developed as well as developing countries like India. This problem is widely observed because of inadequate protein and amino acids supply to the growing child. More than half of these deaths that could have been prevented if children were provided well nutrition. The progress of India in reducing child malnutrition has been slow and needs to improve in many regards. The prevalence of child malnutrition in our country deviates further from the level that is expected at the country's per capita income than in any other large developing country (Braun *et al.*, 2008) [11]. Malnutrition is a major public health problem in low and middle income countries. Worldwide, there are about165 million stunted, 52 million wasted, and 17 million severely wasted under-five children (Black *et al.*, 2013) [35]. Of these, more than half of stunted and more than two-thirds of wasted children live in Asia (De Onis *et al*., 2012) [37] There has been a decline in malnutrition in India in the last decade, but the figures are still alarming. Recent data show that 38.4% Indian children are stunted, 21.0% are wasted, and 7.5% are severely wasted (NHFS 2016). Malnutrition contributes to high morbidity and mortality worldwide. Globally, malnutrition is the underlying cause of death of about 3 million (or 45%) under-five children every year. Of these, 11.6% (804,000) children die due to suboptimum breastfeeding. Strong scientific evidence suggests that insufficient quantities and inadequate quality of complementary foods (CFs), poor child-feeding practices and heavy burden of infectious illnesses have adverse impact on child survival, growth and development. Poverty, food insecurity, ignorance, poor hygiene and sanitation are some other factors responsible for high levels of child malnutrition in developing countries, including India (Ahmed *et al.*, 2012) [36].

Porridge is known to be a traditional and staple food in many of the countries, especially the developing ones. In modern cultures, people are enjoying porridge as a healthy breakfast food. Porridge is a convenient food not just for weaning infants, but also for the elderly and convalescents due to its easy digestibility (Rhim *et al*., 2011) [30]. Depending on the proportion of the cereals and liquid, two types of porridges are prepared for consumption that can be easily distinguished: thick and thin porridges. Thick porridges are solid-like and can be consumed with spoon or hand whereas thin porridge or gruel is taken in by drinking as having fluid or semi-fluid consistency (Moussa *et al*., 2011) [25]. The infants are usually given thin porridge as a complementary meal.

In most of the developing countries, the generality of under nutrition and micronutrient deficiencies is high among infants and young children of the age group 6 to 23 months, which has increased the risk of underweight, stunt growth, and death at these ages (UNICEF, 2009) [32]. Ideally, the children in this age range are breastfed; however, as they get older, the energy and nutrient contribution of complementary food become increasingly necessary for meeting their daily requirements. For many infants and young children, however, the small quantities of cereal-

based porridges commonly fed to them do not contain enough of energy and micronutrients that can meet their daily requirements (Nestel *et al.,* 2003) [27]. Accordingly, articulation and development of nutritious weaning foods from local and readily available raw materials has received more of considerable attention in many developing countries. The commercially standardized foods are generally notable and can help in meeting the nutritional requirements of young children in both developed as well as developing countries (Asma *et al*, 2006) [5].

The word Weaning means the process of gradually replacing mother's milk or milk substitute with usual family diet (WHO, 1989: IFIS, 2009) [33, 16]. Many literatures pointed out that the weaning period is a particularly critical period of life with a high morbidity and mortality from diarrhoeal diseases via contaminated weaning foods in erroneous environments (Elegbe and Ojofeitimi, 1980; Black *et al*., 1989; Motarjemi *et al*., 1993; WHO, 1993) [14, 10, 24, 34]. Weaning foods made from ingredients do not differ from these for adult foods so that the same types and levels of microorganisms would occur on these ingredients naturally (ACMSF, 2006) [1]. The most important sources of microbial contamination of cereal grains are soil, water, air, dust, insects, rodents, birds, animals, humans, storage containers of shipping and storage, handling and processing equipments (Bullerman and Bianchini, 2009) [12]. Commercial weaning foods are easy to prepare, hygienic provided it is packaged, but expensive and not available everywhere locally. On the opposite, the traditional weaning foods are cheaper, always available locally (Castel and Wijngaart, 2005) [5].

The weaning period is a crucial period in an infant's life. At the age of 5–6 months, most infants begin to eat supplementary semisolid foods. At this stage homogenized infant foods play a major role in their nutrition (Martinez *et al*. 2004) [23]. Weaning foods (WFs) for a child in a developing country like Nigeria where WFs are relatively expensive is out of reach of a majority of the people and may result in malnutrition and pose a risk to the life of a child, particularly if the parents are low-income earners. Most WFs commonly sold in Nigeria are composed mainly of cereal grains which contribute about 42% of the total daily calories and 49% of the total daily protein (Keshinro *et al*. 1993) [19]. The maize (corn)-based products are usually in the form of porridges such as pap. Wet sieving and steeping have considerable effects on the protein losses in pap resulting in pap being a poor WF for infants (Banigo and Muller 1972) [7].

Multigrain mix nutrition Dalia/Porridge is an astonishing breakfast meal that is packed with minerals, vitamins, an amazing amount of protein, Energy, carbohydrates and dietary fibre. Multi Grain Dalia is a whole grain product. Its key benefit lies in its nutritional value that helps in lowering cholesterol, and hence aids weight-loss. It is very delicious in taste, with a mildly sweet nut like flavour and contains a myriad of beneficial nutrients. It is nearly 15% of Proteins, which contains high amount of fibre, B-Complex Vitamins including Niacin, Thiamin and Riboflavin, essential Amino Acids, Methionine, Lecithin and some Vitamin E.

Cereals are limited in essential amino acids such as lysine even though rich in Threonine and Tryptophan, while most oil seeds and legumes are rich in lysine and deficient in sulphur containing amino acids, (Many 2008) [22]. Therefore, the combination of cereals, legumes and pulses in formulation of Dalia/Porridge gives a nutritious food containing all the amino acids. Wheat is a good source of thiamine and nicotinic acid, but is relatively poor in riboflavin. Wheat is consumed in India mainly in the form of traditional products. Wheat porridge, popular in many parts of northern India, is made by cooking wheat grits, known as Dalia/Porridge with water or milk and adding sugar to taste. It is also consumed as a savoury dish after cooking with water, vegetables and spices. The wheat grits are prepared by coarse grinding of either polished or unpolished, cleaned wheat in a plate mill to a particle size of 300-850 µm (Sai Manohar *et al.* 1998) [31].

Maize is an important cereal and is used together with other cereals to reduce the food insecurity problems and thus promote survival in rural areas (Afoakwa *et al*, 2010) [2]. The main products obtained from the white maize kernels (maize meal) are thin and thick porridges and breakfast cereals. The thin porridges are made through a combination of many processing methods like malting and fermentation in conjunction with the unit operations like dehulling, soaking, size reduction and drying so as to come out with high quality product (Afoakwa *et al*, 2010) [2]. Fermentation of maize constitutes an important part of the diet in many African countries as it improves the product quality by souring, leading to an improvement in its taste, flavour and texture (Mohiedeen *et al*, 2010). It was also found to increase shelf-life, improve palatability, nutrient digestion and nutritional value (Mohiedeen *et al*, 2010).

Bengal gram helps increase the total energy in the body, which is why it is fed to horses too. Chana is the richest source of protein in legumes and hence helps fuel the body. Methionine, a type of amino acid present in chana is beneficial in the proper functioning of the cells.

Materials and Methods

The present work "Preparation of Process optimization of low cost weaning food by incorporating multinutrient mixes" was conducted in the Food Technology Laboratory, Department of Warner College of Dairy Technology, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad. The details of materials, experimental procedure and techniques adopted during the course

Procurement of raw material

All ingredients (Wheat, Maize, Bengal gram) were purchased from the local market of Allahabad.

Experimental site: The analysis part of present investigation was carried out in the Food technology Laboratory of Department of Warner college of Dairy Technology.

Plan of Work

Development of weaning food

Weaning powder was prepared by mixing all the ingredients (Wheat grits, Maize grits, and Bengal gram flour, Milk and Jaggery) in different proportions and reconstituted with water/milk separately for sensory acceptability. 100 g of weaning food was dissolved in 80 ml of lukewarm water/milk and 40 g jaggery was added as a sweetener for sensory evaluation.

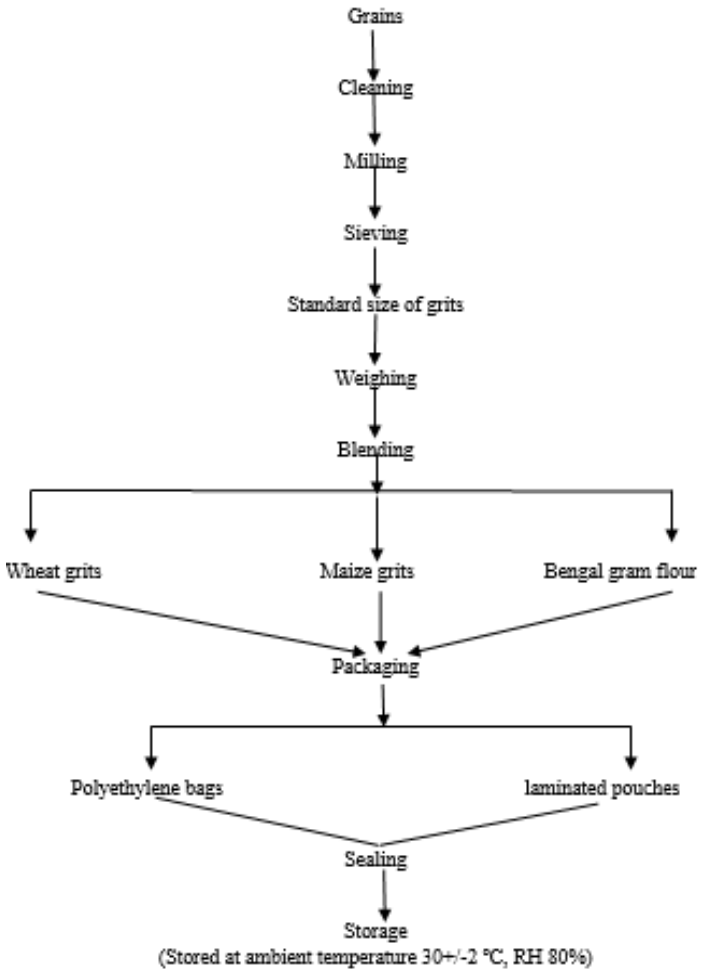

Fig 1: Preparation of wheat grits (WG), maize flour (MF), Bengal gram flour (BGF)

Table 1: Details of weaning food combination

Ingredients\ Treatments	Wheat grits (%)	Maize grits (%)	Bengal gram flour (%)
T0	100	0	0
T1	50	35	15
T2	60	25	15
T3	70	15	15

Replication: - All treatments were replicated 4 times.

Organoleptic Analysis

The formulation was evaluated on the basis of sensory attributes by using nine point hedonic scales by a panel of seven judges.

Chemical Analysis

The developed weaning food was analyzed for Crude fat, fibre, ash, moisture and carbohydrate were analyzed by following the AOAC method (2000). The soxhlet method was used for total fat determination using ether for oil extraction. Crude fibre was obtained after samples digestion with diluted acid, alkali and alcohol. Moisture was determined from sample weight loss after drying at 105° C in dehydrator until constant weight. Protein content was determined by Kjeldahl method and Carbohydrate was calculated by difference method and energy was calculated. Calcium estimation was done by electrolyte analyser and iron was estimated by using Spectrophotometer. All samples were analyzed in triplicate.

Statistical analysis

All the data are presented as mean ± SD (standard deviation) of three replicates. Data of sensory attributes of weaning food was subjected to analysis of variance and significant difference at 5% level.

Result and Discussion

The formulated weaning foods were evaluated for sensory attributes and results are presented in Table 2. The mean scores obtained from sensory evaluation showed that all treatments were accepted. There were significant ($P< 0.05$) differences between overall acceptability of all the formulations.

The data illustrated in the table 2 shows the average sensory scores of different parameters in weaning food clearly indicates that treatments T3 (8.46) had the highest score for colour followed by T2 (8.17), T1 (7.83) and T0 (7.76). In case of taste and flavour, T3 (8.63) had the highest score followed by T2 (8.3), T1 (7.67) and T0 (7.44). T3 (8.13) had the highest mean score for consistency followed by T2 (8.32), T1 (7.56) and T1 (7.78). The average sensory scores of overall acceptability of *weaning food* shows that treatments T3 (8.62) had the highest score followed by T2 (8.47), T1 (7.70) and T0 (7.68). Among the treatments, T3 had highest average mean scores for all the sensory attributes which indicates that an increase in the amount of Maize grits sensory attributes of the weaning food gradually decreases.

There was a significant difference between the treatments at 5% probability level. The calculated value of F is greater than the tabulated value of F at 5% probability level. Therefore, it can be concluded that there was significant difference between treatments of weaning food regarding the various sensory attributes (colour and appearance, taste and flavour, consistency and over all acceptability). Nazni and Suresh Kumar (2011) reported the same findings in their work.

Table 2: Mean scores of weaning food on the basis of various sensory attributes

Sensory attributes	T0	T1	T2	T3
Colour & appearance	7.76	7.83	8.17	8.46
Taste and flavour	7.44	7.67	8.30	8.63
Body & texture	7.78	7.56	8.32	8.13
Overall acceptability	7.68	7.70	8.47	8.62

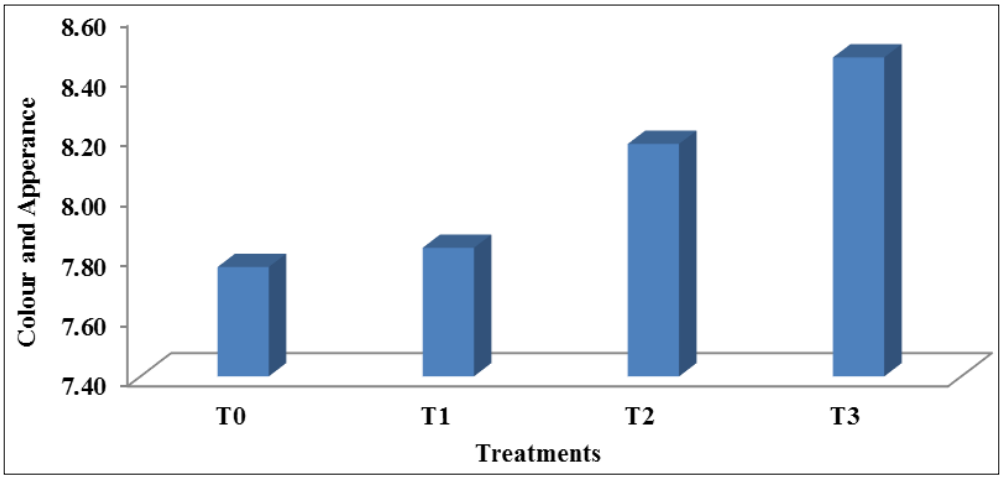

Fig 1: Average of data obtained on Colour and appearance of low cost weaning food by incorporating multinutrient mixes

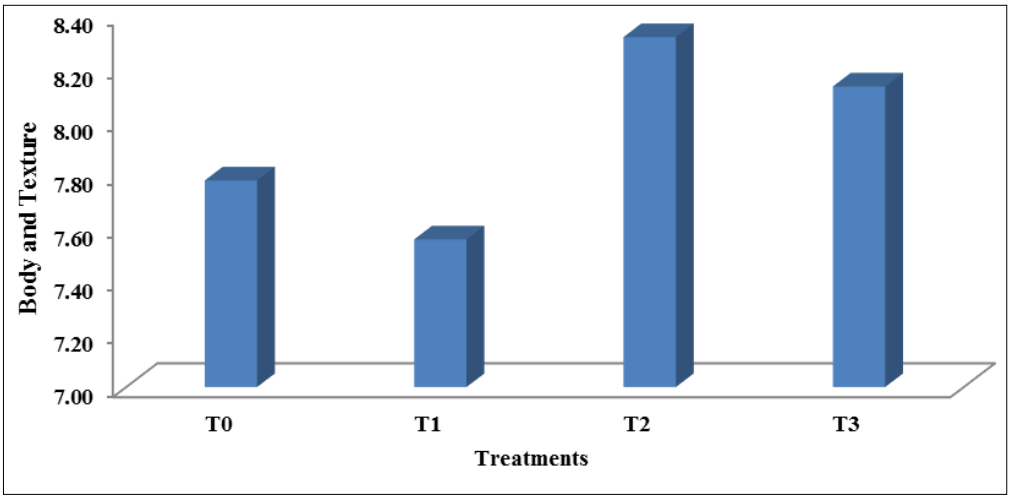

Fig 2: Average of data obtained on body and texture of low cost weaning food by incorporating multinutrient mixes

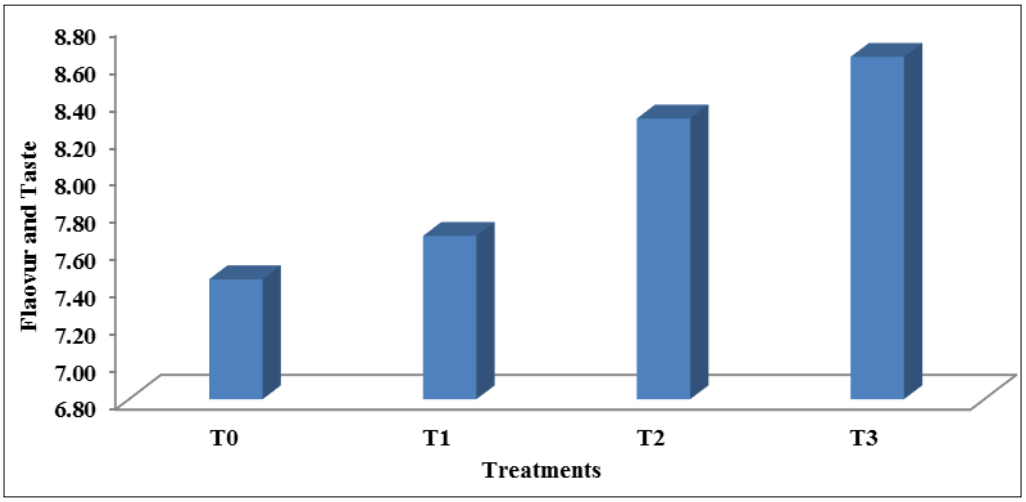

Fig 3: Average of data obtained on flavour and taste of low cost weaning food by incorporating multinutrient mixes

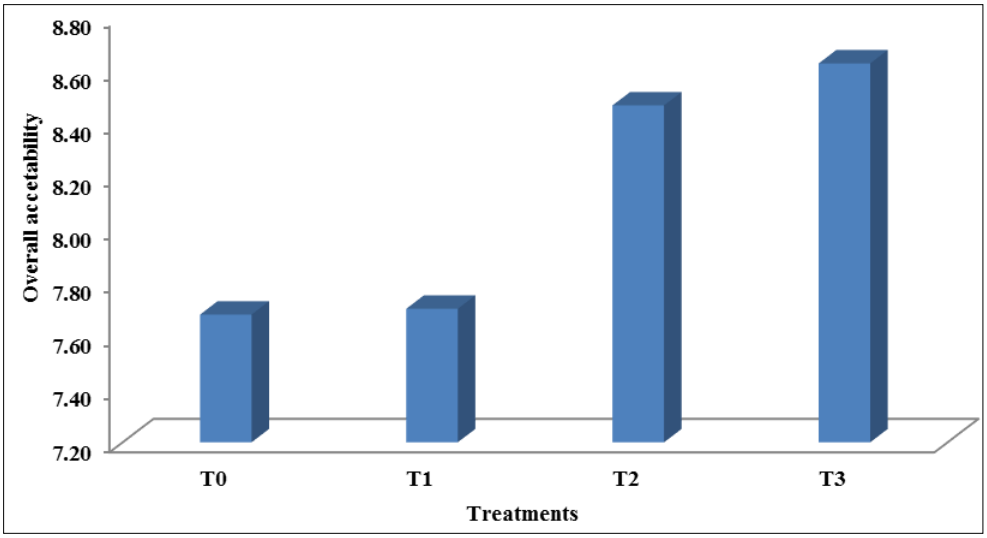

Fig 4: Average of data obtained on Overall acceptability of low cost weaning food by incorporating multinutrient mixes

Table 3: Nutritional composition and costing of the weaning food per 100gm

Nutrient	T0	T1	T2	T3
Moisture (gm)	8.41	9.92	10.46	11.34
Ash (gm)	0.94	1.30	2.10	2.64
Protein (gm)	10.57	11.24	13.37	16.19
Fat (gm)	6.36	11.60	14.60	16.60
Fibre (gm)	1.00	2.04	2.52	3.10
Carbohydrate (gm)	71.28	63.36	56.24	51.49
Calcium (mg)	41.02	42.62	42.96	68.04
Iron (mg)	5.36	5.70	6.00	6.96
Cost/100gm	1.9	3.6	3.29	2.98

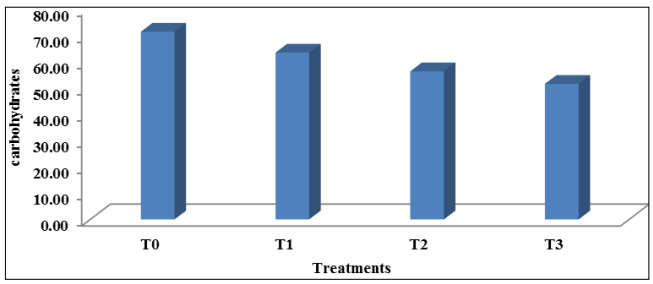

Fig 5: Average of data obtained on carbohydrates of low cost weaning food by incorporating multinutrient mixes

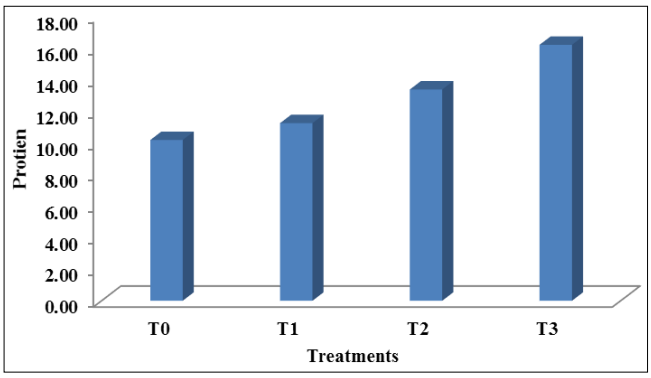

Fig 6: Comparison of average protein content of low cost weaning food by incorporating multinutrient mixes

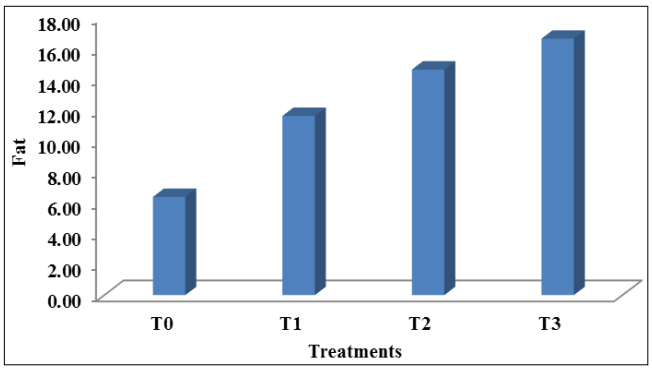

Fig 7: Average of data obtained on fat content of low cost weaning food by incorporating multinutrient mixes

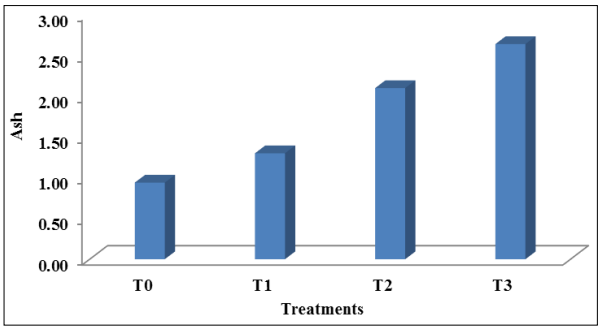

Fig 8: Average of data obtained on ash of low cost weaning food by incorporating multinutrient mixes

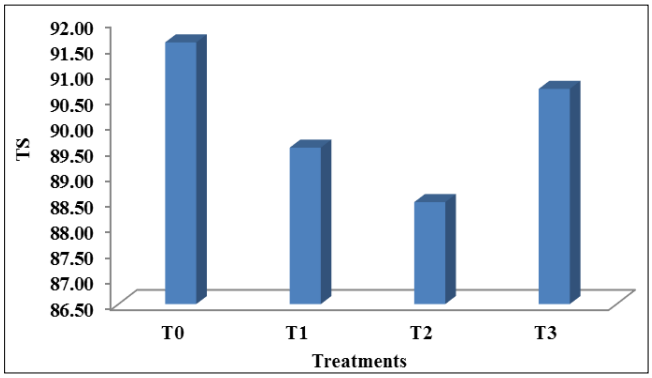

Fig 9: Average of data obtained on TS of low cost weaning food by incorporating multinutrient mixes

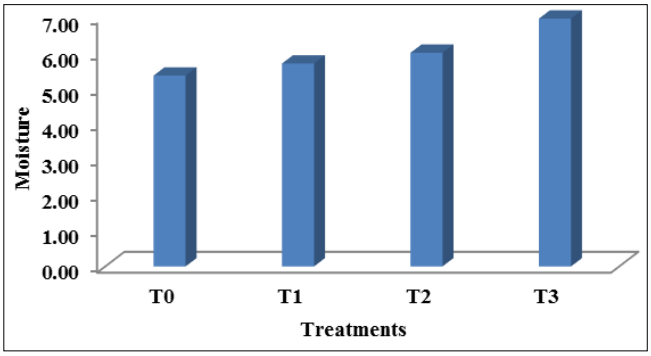

Fig 10: Average of data obtained on moisture of low cost weaning food by incorporating multinutrient mixes

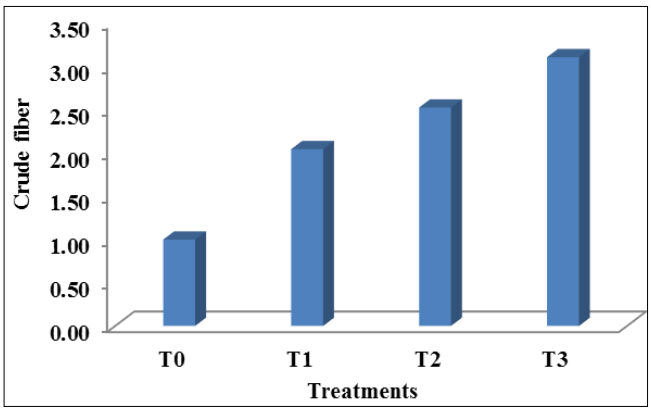

Fig 11: Average of data obtained on crude fibre of low cost weaning food by incorporating multinutrient mix**es**

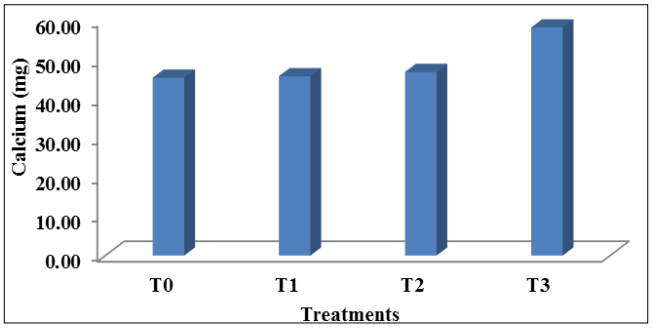

Fig 12: Average of data obtained on calcium (mg) of low cost weaning food by incorporating multinutrient mixes

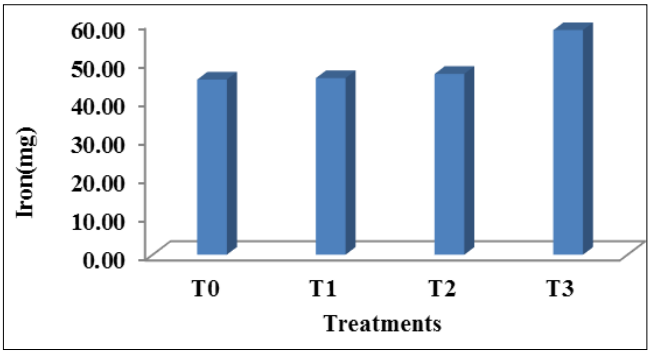

Fig 13: Average of data obtained on iron of low cost weaning food by incorporating multinutrient mixes

The developed instant baby food was analyzed for moisture, ash, protein, carbohydrate, fat, fibre, calcium and iron content as methods described in AOAC (1990). The cost of food was determined on raw basis. The nutritional composition and cost of the weaning foods prepared using different composition was shown in table 3. Result revealed that highest Protein content was highest in T3 (16.19 g) followed by T2, T1 and T0. Carbohydrate content also increased with the increase in amount of wheat grits i.e.T0 (71.28g), T1 (63.36 g), T2 (56.24 g) and T3 (51.49 g). Minerals (Calcium and Iron) are also highest in T4 followed by T3, T2 and T1. Therefore, it can be concluded that weaning food prepared by using the cereal and legumes are highly nutritious.

Conclusion

On the basis of the above findings it is concluded that the weaning food can be prepared by using wheat grits, maize grits and Bengal gram flour.

On the basis of organoleptic quality the incorporation level of wheat grits: maize grits: Bengal gram flour in the ratio of 40:25:35 (T3) was found most acceptable with regards to colour and appearance, consistency, taste and flavour and overall acceptability. The prepared weaning food are rich in protein, fat, calcium, iron thus the prepared weaning food are nutritious for infant health and growth.

The nutrients content of the prepared weaning food was fat (6.36-16.60 g), protein (10.57-16.19 g), carbohydrate (71.28-51.49g), crude fibre (1.00-3.10 g), total ash (0.94-2.64 g), calcium (45.34-58.15 mg) and iron (5.36- 6.96g). The cost of prepared weaning food was lowest in T3 (43.1 Rs/Kg.) followed by T2 (44.3 Rs/Kg) and T1 (45.5 Rs/Kg).

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